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EXAMINATION ON YIELD AND SOME YIELD ASSOCIATED PARAMETERS IN DIFFERENT RICE GENOTYPES

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Abstract

The aim of this paper was to evaluate the grain yield and some yield related traits in different rice genotypes grown in the Republic of Macedonia. Nine rice genotypes (Prima Riska, 78/12-3-1, 79/22-2, Ronaldo, Onice, Opale, Gloria, Pato and San Andrea) were used for this research. All rice genotypes were from Italy except Prima Riska variety and two promising lines (78/12-3-1 and 79/22-2) which have Macedonian origin. The field experiments were carried out during 2014 and 2015 on the field areas in Kocani, Republic of Macedonia. Each genotype was set up on 5 m2 test area in three repetitions in randomized block design. Grain yield and some important yield associated traits, like plant height, panicle length, 1 000 grain weight and the number of plants per m2 were evaluated. This study investigated the effect of genotype and environment, but also their interaction on the grain yield. Besides the importance of genotype, the analysis of variance showed that the grain yield was strongly affected by environmental conditions (over 87 %). The average grain yield for all tested genotypes during the period of study was 6 100 kg/ha.

Key words: *grain yield, rice, agronomic traits, genotype*

INTRODUCTION

Rice (*Oryza sativa* L.) is a member of *Graminaeae* family and it is one of the most important cereals cultivated worldwide, constituting the basic food for large number of human beings, sustaining 2/3 of the world population (Zhout et al., 2002). The world's farmers have to produce about 60 % more rice than at present to meet up the food demands of the expected world population by 2025 (Fageria, 2007).

In the Republic of Macedonia, rice production has an important role in economy, because it provides sufficient rice for domestic needs and a significant part of rice production is export-oriented. Among the production factors, selection of variety plays an important role in the productivity of rice in any location (Alam et al., 2009).

In recent years, the main varieties in rice production in Macedonia are the Italian varieties San Andrea and R-76/6, which account for more than 90 % of the total production. The remaining part is represented by newly introduced varieties from Italy (Opale, Onice), Turkey (Halilbey) and selected domestic varieties (Prima riska and Biser-2).

In general, the productivity of this crop can be influenced by environmental conditions such as solar radiation, temperature and water availability during growth and development (Fageria, 2007). Grain yield depends on genotype, environment and management practices and their interaction with each other (Messina et al., 2009). Under the same management conditions, the variation of grain yield is principally explained by the effects of genotype and environment (Dingkuhn et al., 2006). Interaction between these two explanatory variables gives an insight in identifying genotype suitable for specific environments (Suchit et al., 2011).

The low heritability of grain yield characters made selection for high yielding varieties possible usually using various components

traits associated with yield (Atlin, 2003). Many researches confirmed that rice yield depends on a lot of number of traits, such as: the number of plants (the number of panicle per unit area), plant height, panicle length, the number of grains per panicle, the weight of the grains in panicle and 1 000 grain weight. The significance of each of these properties depends on climatic conditions and the water regime during the vegetation, as well as applied agro-technical measures.

Today, rice selection is mainly aimed at increasing the grain yield potential, improving the chemical and technological properties, good adaptability, shorter vegetation and shorter stem. Complex interactions between these indicators are exiting, because when increasing the value of one parameter, the value of another is often reduced.

The aim of this paper is to examine and evaluate the grain yield and some important yield associated properties in rice varieties which are dominate in rice production in Macedonia, in varieties that are recently recognized and in varieties and genotypes that according to the preliminary results represent a perspective for rice production in the Republic of Macedonia.

MATERIAL AND METHODS

Plant material and experimental design

During two years (2014 – 2015), nine rice varieties were cultivated and evaluated in agro-ecological conditions in Republic of Macedonia. Five of them were newly introduced varieties from Italy (Ronaldo, Opale, Onice, Gloria and Pato), one variety is domestic selection (Prima riska) and two are domestic prospective lines (78/12-3-1 and 79/22-2). San andrea, also Italian variety, was used as an experimental material and this cultivar for a long period is main variety in commercial rice production in Macedonia. The experiment was performed on alluvial soil type in the region of Kocani. Each test area was 5 m^2 set in three repetitions in randomized block method. In both years of research, rice was pre-crop. In 2014, the sowing was conducted on 25 April and in 2015 on 7 May. During the vegetation, standard agronomic practices were used. Before sowing, 500 kg/ha of NPK fertilizer (15:15:15) and 200 kg/ha Urea (46 %) were applied and during vegetation 100 kg/ha ammonium nitrate (34 %), of which 50 kg/ha during tillering and 50 kg/ha during heading was used. For weeds control, Basagran (4 l/ha), Rainbow (1.5 l/ha) and Clincher duo (1.5 l/ha) were applied.

Data collection

Ten randomly selected plants from each repetition have been analyzed for the plant height (cm) and panicle length (cm). The number of plants per m^2 was determined by counting the plants from m^2 of each repetition. 1 000 grains weight, has been determined to measure 1 000 grains of each repetition. Grain yield obtained from 5 m^2 was calculated in kg/ha. The moisture content was reduced in 14 %, when was calculated the 1 000 grains weight and grain yield.

Statistical analysis

For analysis of variance (ANOVA) the statistical package SPSS (2010) was used. Least significant difference (LSD) was calculated using Statistical analysis system software JMP (2002).

RESULTS AND DISCUSSION

The results of mean values for grain yield and some yield associated traits are shown in Table 1. Significant differences were found between the tested varieties for all analyzed properties.

Yield superiority was shown by Ronaldo variety (7 082 kg/ha) and Prima riska (7 057 kg/ha) but the lowest grain yield was obtained from Gloria variety (4 766 kg/ha). The paddy yield obtained from genotype 78/12-3-1 (6 753 kg/ha) statistically does not differ significantly from the yield received from Ronaldo and Prima riska. The average value for grain yield for all tested varieties during the period of study was 6 100 kg/ha.

Table 1. Mean values for yield and some yield related traits in rice varieties (2014-2015).

Variety	Plant height (cm)	Panicle length (cm)	1000 grain weight (g)	Number of plants per m^2	Grain yield (kg/ha)
Prima riska	92a	19a	38,82b	449bc	7 057a
78/12-3-1	88b	19a	35,09c	502ab	6 753a
79/22-2	86b	17b	41,21a	468bc	6 540ab
Ronaldo	54b	16cd	32,21d	446bc	7 082a
Onice	82c	12g	32,58d	464bc	5 885bc
Opale	62d	14f	32,44d	432c	5 768c
Gloria	57e	15de	41,12a	443bc	4 766d
Pato	63d	14ef	42,39a	438bc	5 234cd
San Andrea	88b	16bc	39,49b	538a	5 815c
Mean	**75**	**16,0**	**37,26**	**465**	**6 100**
Minimum	**43**	**9**	**28,34**	**202**	**1 972**
Maximum	**107**	**25**	**48,50**	**720**	**11 400**
$LSD_{0.05}$	**3,60**	**1,09**	**1,39**	**68,92**	**659,40**
CV (%)	**2,81**	**4,05**	**2,18**	**8,65**	**6,30**

The results of many researches show that the grain yield is determined by the three main components such as: the number of panicles per unit area, the number of grains per panicle and 1 000 grain weight. San Andrea has the largest number of plants per m^2 (538), followed by genotype 78/12-3-1 (502). Opale variety showed the lowest number of plants (432).

1 000 grain weight varies from 32.21 g in variety Ronaldo to 42.39 g in Pato cultivar.

Significant impact on grain yield has panicle length. Longer panicle length usually is associated with a larger number of grains. Plants which have longer panicle, can serve as a source of assimilates because of more active photosynthesis. From this study Prima riska and 78/12-3-1 have the longest panicle (19 cm) while the shortest was recorder by Onice variety (12 cm). The average value for this trait was 16.0 cm for all tested varieties.

Prima riska variety also was the highest (92 cm) from all tested varieties.

Significant differences between the varieties show the presence of genetic variability among them and give a great opportunity to improve the yield. The obtained results for the tested properties show that all investigated genotypes are significant and have great potential for yield. Their inclusion in selection programs to improve these properties can be effective for further rice improvement.

The results from ANOVA obtained from the research are given in Table 2.

Grain yield was significantly affected by the year, while the influence of the variety and the interaction of variety and year have not shown significance. The impact of the year on yield formation was 87.95 % while from the variety 7,61 %. The least influence on paddy yield has the interaction between variety and year (4.44 %).

Table 2. The influence of variety, year and their interaction on grain yield.

Factor	Sum of Squares	df	Mean Squere	F	η
Total	424,949	53			
Factor (A) - variety	31,600	8	3,950	14,512	7,61
Factor (B) - year	365,134	1	365,134	1341,501	**87,95***
A x B	18,417	8	2,302	8,458	4,44
Error	9,799	36	0,272		

The vegetation period in both years of study differed in ration of air temperatures, amount and schedule of precipitations. Deviations in temperatures were more pronounced during the blooming and spraying the grains. Negative impact on grain yield in the second year of the trials has the precipitations during grain spraying and ripening. Frequent and heavy rainfall prolonged the harvest. Additional and the worst negative impact on the research has unfavourable water regime during and after the treatment with herbicide in the second testing year. According to this, the destruction of the weeds was not timely and fully effective.

CONCLUDING REMARKS

The results from the study had proved significant differences between tested rice genotypes for all analyzed traits.

Genotypes Ronaldo, Prima riska and 78/12-3-1 have shown the highest yield potential. Prima riska is already recognized domestic variety, present in rice production but with better agro technology measurements can be much better ranked in rice assortment. Ronaldo, Pato, 78/12-3-1 and 79/22-2 with additional researches may also be more popular among rice manufactures. For a longer time in rice production, San Andrea variety has the dominant role and this study shows that it is still justifies the "backbone" of rice production. The presence and use in rice production of genotypes Onice, Opale, Pato and Gloria is also justified. All genotypes, used in this research, under favourable external conditions and application of more intensive modern agro-technology, can further exploit their potential. All genotypes can also be used as parents in breeding programs for creation of new rice genotypes, in order to get the new high yielding varieties.

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ИСПИТУВАЊЕ НА ПРИНОСОТ И НЕКОИ КОМПОНЕНТИ НА ПРИНОС КАЈ РАЗЛИЧНИ ГЕНОТИПОВИ НА ОРИЗ

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Резиме

Целта на овој труд беше да се испита приносот на зрно и некои компоненти на принос кај различни генотипови на ориз одгледувани во Република Македонија. Девет генотипови на ориз (*Prima Riska*, *78/12-3-1*, *79/22-2*, *Ronaldo*, *Onice*, *Opale*, *Gloria*, *Pato* и *San Andrea*) беа употребени како епксперименталeн материјал. Сите генотипови имаат италијанско потекло, со исклучок на *Prima Riska* и две перспективни селекциски линии кои имаат македонско потекло. Експерименталните опити беа поставени во текот на 2014 и 2015 година на опитните површини во Кочани. Секој генотип беше поставен на опитни површини од 5 m^2 во три повторувања во рандомизиран блок систем. Во текот на двете години од истражувањата беа анализирани следниве својства: принос на зрно, како и некои важни компоненти на приносот, висина на растение, должина на метличка, маса на 1000 зрна и број на растенија на m^2. Истражувањето имаше за цел да го утврди и влијанието на генотипот, годината како и нивната интеракција врз приносот на зрно. Освен значајноста на генотипот, со анализа на варијанса се покажа дека условите на надворешната средина (годината) силно влијаат врз приносот на зрно (над 87 %). Просечната вредност за принос на зрно за сите испитувани генотипови беше 6100 kg/ha.

Клучни зборови: *принос на зрно*, *ориз*, *компонети на принос*, *генотип*